
A New, Threatened Species of *Tetraplasandra* (Araliaceae) from Kaua'i, Hawaiian Islands, and Notes on its Conservation Status

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ABSTRACT. *Tetraplasandra flynnii* is described from Kaua'i, Hawaiian Islands. It resembles the more widespread *T. kavaensis*, but is restricted to a single known population now comprising only three individuals growing in mesic to wet forest that is increasingly impacted by introduced goats and aggressive non-native plant species. Material has been propagated for ex situ conservation, but effective management will be required to ensure the continued survival of the wild population.

The remarkable flora of the Hawaiian Islands has received renewed attention from field botanists and taxonomists since the mid 1980s, stimulated by the *Manual of the Flowering Plants of Hawai'i* project (Wagner et al., 1990). In addition to carrying out a comprehensive re-assessment of species limits and distributions within Hawai'i, the project also served as a catalyst for exploration, especially in areas that had previously been neglected. Botanically, Kaua'i is perhaps the least well known of Hawai'i's eight main islands, and its highly dissected topography, with many deep valleys and steep, often vertical slopes, presents special challenges for plant collecting. Recent fieldwork aimed at documenting the island's flora has generated many interesting collections, including several new species, one of which is described here.

The continued survival of wild populations of many native Hawaiian endemics is increasingly threatened because of extensive habitat degradation or loss. For this reason, the National Tropical Botanical Garden (NTBG) has placed special emphasis on assessing the geographic distribution of the most restricted and vulnerable of these endemic species, and on studying their population structure and genetics so that appropriate measures can be undertaken using both in situ and ex situ conservation techniques. Our new species of *Tetraplasandra* is one of these very rare single-island endemics, and we hope that by describing it here and detailing the current plight of the only known population, we can stimulate action by those in a position to implement effective protection.

Tetraplasandra flynnii Lowry & K. R. Wood, sp. nov. TYPE: U.S.A. Hawaiian Islands. Kaua'i: Waimea Dist., Koke'e State Park, Kalalau Valley, steep forested slope of SE rim, ca. 1175 m, 22°09'N, 159°38'W, 17 Aug. 1988 (fl, fr), *Flynn 3103* (holotype, PTBG (1871, 1872); isotypes, BISH, F, K, MO (3595738, 3595740, 4629226), P, US (2 sheets)). Figures 1–3.

Haec species *T. kavaensis* affinis, sed ab ea reproductionis systemate andromonoico, ovario 5-carpellari omnino infero, petalis majoribus 8.0–12.5 mm longis atque fructu urceolato majore 15–18 × 10–12 mm metiente in columnam stylarem conicam desinente differt.

Andromonoecious trees ca. 7–9 m tall, well branched above the middle. Leaves pinnately compound, 28–57 cm long, densely rusty brown to tawny farinose stellate pubescent throughout except on the upper surface of the leaflets; petiole 7–17 cm long, stout, ca. 4–8(–10) mm diam. at the base; rachis articulated at the petiolule bases; petiolules of lateral leaflets (2–)5–22 mm long, those of the terminal leaflet (17–)20–50 mm long; leaflets 5 to 9, narrowly ovate to elliptic, 4–8 × (5.5–)7–17 cm, the lowermost pair sometimes reduced, lamina glossy green and glabrous above, often with a whitish scurf, midvein yellow-green, farinose stellate pubescent below with evident yellow-brown venation, apex acute to nearly rounded, margin entire, minutely revolute, base acute to rounded or subcordate, usually oblique on the lateral leaflets. Inflorescence axillary, paniculate-umbellate, pendent, densely brown farinose stellate pubescent throughout, primary axis stout, (5–)6–13 cm long, secondary axes (2–)3–6, 2–4 terminal and (0–)1–2 inserted laterally along the primary axis, the uppermost secondary axes (peduncles) 6–10 cm long, bearing ca. 10 to 15 hermaphrodite flowers, ca. 3 to 8 forming a terminal umbellule and the others scattered along the axis, the lowermost generally abortive and leaving an evident scar, the lower secondary axes (when present) sometimes further divided, 13–15 cm long, with 10



Figure 1. *Tetraplasandra flynnii* Lowry & K. R. Wood. —A. Branch with buds, flowers, and young fruits. —B. Detail of ultimate inflorescence branch with buds and flowers. —C. Mature fruits. —D. Stamens. Drawn from *Flynn 3103*.

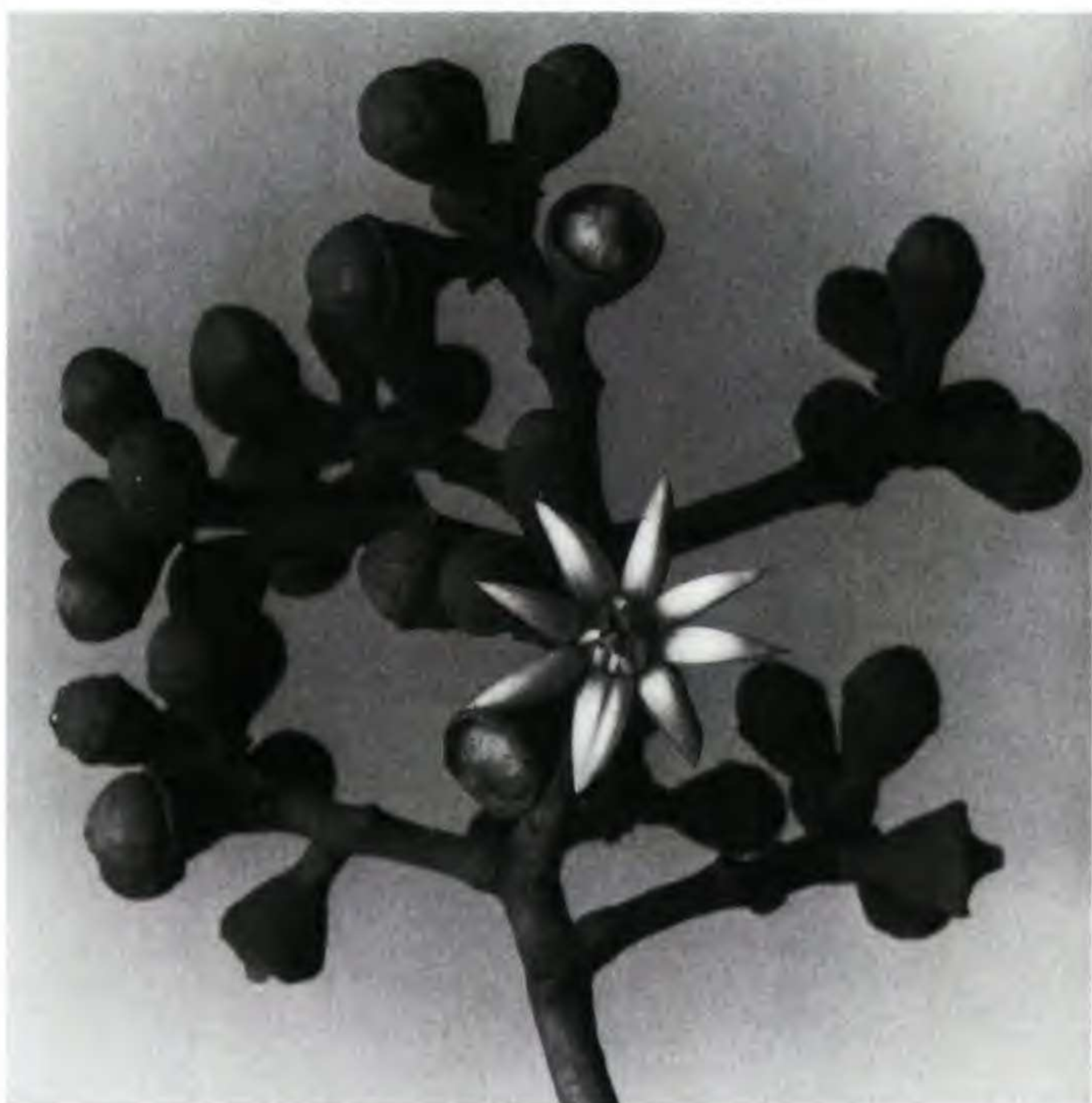


Figure 2. *Tetraplasandra flynnii*.—Branch with buds and open flower. Photograph of Wood 7156; courtesy of D. Liittschwager & S. Middleton.

to 12 tertiary axes (peduncles) bearing ca. 7 to 15 apparently staminate flowers, 3 to 6 forming a terminal umbellule and the others borne mostly in the distal half, many early abortive and leaving an evident scar, pedicels stout, 2–7 mm long, ca. 3–4 mm diam. in hermaphrodite flowers, ca. 2 mm diam. in staminate flowers. Calyx cupuliform, shallow, ca. 1 mm high at anthesis, expanding to ca. 2 mm in fruit, irregularly undulate. Corolla depressed-rounded to broadly obtuse or nearly triangular in bud, petals 10 (or 11), sometimes remaining united in pairs at anthesis and appearing fewer in number, lanceolate-triangular, yellow-green, fleshy, coriaceous when dry, densely farinose stellate pubescent on the dorsal surface, glabrous within, in hermaphrodite flowers 5–6 mm long in bud expanding to 8–12.5 mm at anthesis, smaller in staminate flowers, up to 4–5 mm at anthesis. Stamens 10 (or 11), in hermaphrodite flowers the filaments thick, ca. 4 mm long, the anthers 3–3.5 mm long, in staminate flowers the filaments 2–2.5 mm long, the anthers 2.5 mm long. Ovary 5-carpellate, fully inferior, obconic in bud, becoming somewhat urceolate at anthesis, especially in hermaphrodite flowers, surmounted by a concave nectar disk tapering into a stout column of 5 fused styles, ca. 1–2 mm long at anthesis, expanding to 4 mm in fruit, crowned by 5 sessile stigmas. Mature fruit urceolate, 15–20 mm high, 10–16 mm wide near the middle, 10–12(–16) mm wide distally, with a distinctly expanded calyx rim; nearly mature seeds tan-brown, ovate to elliptic-compressed, broader at base, 11×7 mm.

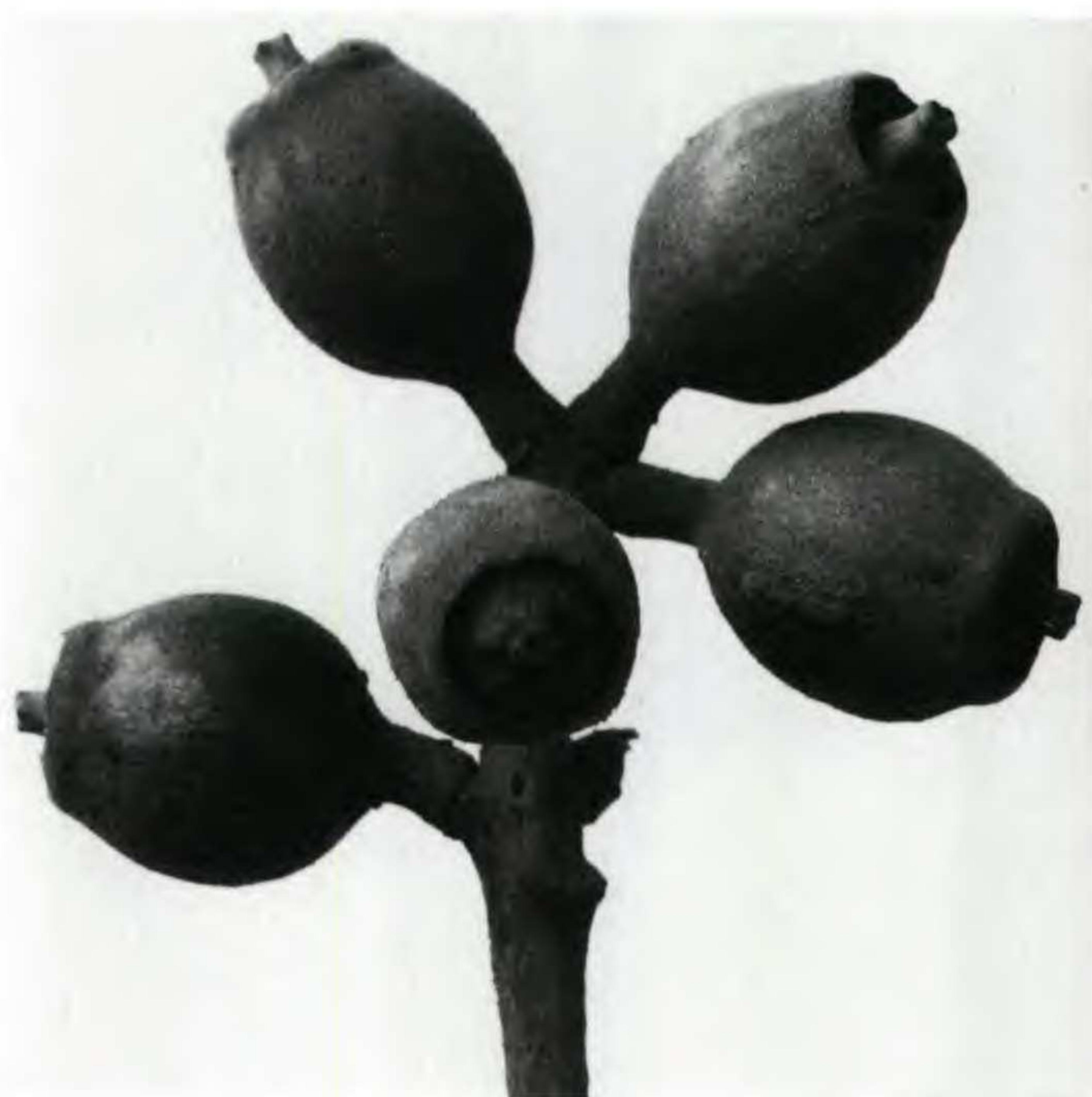


Figure 3. *Tetraplasandra flynnii*.—Nearly mature fruit. Photograph of Wood 7156; courtesy of D. Liittschwager & S. Middleton.

This species is named in honor of Timothy Flynn, Curator of the Herbarium at NTBG, who collected the type material, and who has contributed so much to our knowledge of the rich and highly endemic flora of Kaua'i through nearly two decades of active fieldwork in some of the island's most difficult terrain.

Paratypes. U.S.A. HAWAIIAN ISLANDS. **Kaua'i:** Hanalei Dist., Koke'e State Park, Kalalau Valley, ca. 1060 m, 18 Aug. 1986 (fl, fr), *Flynn & Montgomery 1868* (MO, PTBG [2]); steep forested slope of SE rim, ca. 1175 m, 17 Aug. 1988 (bud, fl, & fr), *Flynn & Hume 3103A* (PTBG [2]), (fl, fr), *Flynn & Hume 3104* (MO [2], PTBG [2]); Hanalei Dist., Na Pali-Kona Forest Reserve, steep SW slope between Kalalau and Puu O Kila lookouts, 1160–1250 m, 9 Nov. 1988 (bud, fl), *Flynn et al. 3210* (PTBG); Kalalau Valley, just below and N of new sanctuary & Kahua'a Flats, steep N-facing *Metrosideros montane* mesic to wet forest, ca. 1180 m, 10 June 1998 (bud, fl, fr), *Wood & Perlman 7361* (BISH, MO, PTBG), 23 July 1998, (bud, fl, fr), *Wood & Agurauja 7403* (PTBG), (bud, fl, fr), *Wood & Agurauja 7404* (MO, PTBG); ca. 1170 m, 28 July 1998 (bud, fl, fr), *Wood & Agurauja 7405* (BISH, MO, P, PTBG, US); ca. 1180 m, 31 Aug. 1998 (bud, fl, fr), *Wood 7456* (BISH, MO, PTBG).

Distribution and ecology. *Tetraplasandra flynnii* is extremely rare, known from only a single population covering ca. 1 km² in the Kalalau Valley of Kaua'i, Hawai'i. Collections have been made in Koke'e State Park, within the Na Pali-Kona Forest Reserve, and between the first and second Kalalau lookouts. The new species occurs on a steep north-facing montane mesic to wet 'ohi'a forest (dominated by *Metrosideros polymorpha* Gaudichaud-Beaupré), with a mostly open canopy that is approximately 10–15 m tall. Other associated tree species include *Xylosma hawaiiense* Seemann, *Psy-*

chotria greenwelliae Fosberg, *Pritchardia minor* Beccari, *Pleomele aurea* (H. Mann) N. E. Brown, and *Dodonaea viscosa* Jacquin. Another Araliaceae endemic to Kauaʻi, *Tetraplasandra waialealae* Rock, occurs sympatrically with *T. flynnii*, but is more widespread and does not appear to be threatened. Understory shrubs growing in the vicinity of the new species include *Styphelia tameiameia* (Chamisso & Schlechtendal) F. Mueller, *Melicope feddei* (H. L  veill  ) T. G. Hartley & B. C. Stone, and *Exocarpus luteolus* C. N. Forbes. *Carex meyenii* Nees, a native sedge, is also common. Terrestrial ferns include *Diplazium sandwicianum* (Presl) Diels and *Odontosoria chinensis* (L.) J. Small.

Affinities. *Tetraplasandra flynnii* most closely resembles *T. kavaensis* (  he  he), which likewise occurs on Kauaʻi but is also found elsewhere in the Hawaiian archipelago. The genus *Tetraplasandra* comprises seven species (including the new one described here), all of which are endemic to Hawai  i. It forms part of a closely related group that also includes *Gastonia* (ca. 8 to 10 species from Madagascar, the Seychelles and Mascarene Islands, Malesia, and the Solomon Islands), *Munroidendron* (1 species endemic to Kauaʻi), and *Reynoldsia* (5 species, 1 each in Hawai  i, the Marquesas, and the Society Islands, and 2 in Samoa). As pointed out by Philipson (1970; see also Lowry, 1987, 1990), these genera are difficult to separate, and limits between them can only be recognized using a combination of morphological characters coupled with geographic distribution, suggesting that they may well represent a single genus. However, until more detailed studies, including phylogenetic analyses using both morphological and molecular data, can be completed, it seems best to place our new species in *Tetraplasandra* along with its closest relatives.

A key to the species of *Tetraplasandra* was provided in the treatment of Araliaceae for the *Manual of the Flowering Plants of Hawai  i* (Lowry, 1990; see also Lowry, 1987), to which the following couplet should be added to facilitate identification of material of *T. flynnii*.

- 4a. Plants with hermaphrodite flowers only, petals 5–7 mm long at anthesis, ovary appearing (1/4–)1/3–3/4 inferior, 2- to 5-carpellate, fruit globose-ovoid to ovoid or cylindrical, 10–15 mm high, 8–11 mm wide, calyx rim a narrow ridge or line, borne near the middle of the fruit, disk expanded, rounded to conical, without an evident stylar column *T. kavaensis* (H. Mann) Sherff
- 4b. Plants andromonoecious, with both hermaphrodite and staminate flowers, petals of hermaphrodite flowers 8–12.5 mm at anthesis, ovary fully inferior, 5-carpellate, fruit urceolate, 15–18 mm high, 10–12 mm wide, calyx rim expanded, borne at the top of the fruit, disk concave, surmounted by a conical stylar column
. *T. flynnii* Lowry & K. R. Wood

Threats and conservation status. The   hi  a forest where *Tetraplasandra flynnii* occurs is being severely impacted as a result of constant browsing by goats (Wood & Perlman, 1993). During field observations made by the second author in June 1998, only three individuals of *T. flynnii* were found, a striking decrease from the approximately nine plants seen in the area prior to Hurricane Iniki, which struck Kauaʻi in 1992. In August 1999 one of these last remaining trees was purposefully girdled by an unidentified visitor to this remote area. An attempt is being made to graft bark material from an individual of *T. kavaensis*, but it is unlikely that the tree will survive.

All three individuals known of *T. flynnii* occur within 200 m of one another. Survey work conducted in August 1998 in adjacent forest of similar structure and composition situated just to the east failed to reveal any other individuals of *T. flynnii*. Kauaʻi has been reasonably well explored botanically, but there is still a small chance that other trees might remain in several isolated regions that have not yet been visited by botanists.

No regeneration of native tree species appeared to be occurring in the area where *Tetraplasandra flynnii* grows. Only four native understory species were found to be reproducing: *Cyrtandra paludosa* Gaudichaud-Beaupr  , *Scaevola procera* Hillebrand, *Lysimachia kalalauensis* Skottsberg, and *Korthalsella platycaula* (Tieghem) Engler. As the older trees die, increased erosion on the precipitous ridges in the Kalalau Valley will continue, threatening the remnant native forest where *T. flynnii* occurs. Although no non-native trees were observed in the immediate area, a number of invasive alien species occur nearby, e.g., at Kahuama  a Flat, including *Corynocarpus laevigatus* J. R. Forster & G. Forster and *Myrica faya* Aiton. These aggressive trees have not yet spread onto the slopes where *T. flynnii* grows, but they present a serious risk. Several very invasive alien herbaceous weeds are, however, already displacing the forest understory in and around the immediate habitat of *T. flynnii*, most notably *Erigeron karvinskianus* DC., which blankets large sections of the region and tends to smother native species. *Kalanchoe pinnata* (Lamarck) Persoon is also a dominant weed in the Kalalau Valley, along with *Rubus argutus* Link, *Holcus lanatus* L., *Bromus rigidus* Roth, and *Setaria gracilis* Kunth.

Tetraplasandra flynnii is one of 116 species of Hawaiian plants currently included in the Genetic Safety Net group. This status applies to endemic species represented by no more than 50 naturally occurring individuals. As *T. flynnii* is presently known from only three individuals, staff members at both the NTBG and the University of Hawai  i  s micro-propagation lab at Lyon Arboretum on O  ahu

have made propagation of this species a priority project. Material collected from all three plants has been successfully propagated using in vitro tissue culture techniques. Seedlings are now growing in cultivation, thereby assuring the short-term genetic conservation of *T. flynnii*. Reintroduction using these seedlings will be attempted in the near future at the Kalalau Plant Sanctuary, located about 300 m from the tree from which the type material of *T. flynnii* was collected.

The continued survival of what appears to be the last remaining population of *Tetraplasandra flynnii* will, however, depend on adequate conservation management in the Kalalau Valley. Implementation of control measures aimed at reducing or eliminating populations of feral ungulates and invasive alien weeds might permit the reintroduction of native key-stone tree species during the wet season. Protection of the Kalalau Valley ecosystem is further justified because it contains two fragmented areas representing the last vestiges of Kaua'i's imperiled diverse mesic forest ecosystem, as well as an important transitional zone between mesic and wet forest communities. This transitional habitat appears to be restricted to the Kalalau Valley, and is especially rich, with several other new species documented from the region in recent years (Wood & Perlman, 1993), including *Hibiscadelphus woodii* Lorence & W. L. Wagner, *Dubautia kenwoodii* G. Carr, and *Lysimachia scopulensis* K. Marr, among others.

Several forested areas occurring within 5 km of *T. flynnii* provide critical habitat for 117 plant taxa known from only Kaua'i (Wood, unpublished data). These single-island endemics appear adapted to particularly narrow niches, and illustrate the phenomenon of prolific speciation and divergence

through isolation, often observed in insular situations (Carlquist, 1974). These endemics are also probable host plants for an unknown number of native arthropods that have evolved to occupy their own microhabitats (Wood, unpublished data).

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